

# Testing REST API Servers

Building Confidence in Your Web Services

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## Learning Objectives

By the end of this lesson, you will understand:

- **Why** we need to test REST APIs
- **How** to test API endpoints using **JavaScript** and **CURL**
- **What** makes a good API test
- **When** to run different types of tests

# **Why and How to test REST APIs?**

## 🤔 Why Test REST APIs?

### Reliability 🛡️

- Ensure your API works as expected
- Catch bugs before users do
- Maintain service quality

### Documentation 📖

- Tests serve as living examples
- Show how the API should be used
- Prove API functionality

### Confidence 💪

- Safe to make changes
- Deploy with assurance
- Reduce production issues

### Communication 🗣️

- Clear expectations
- Team understanding
- Client integration

## How - Two Types of API Tests

### 1. **Connection Tests** "Is the server alive?"

- Server responds to requests
- Returns valid HTTP status codes
- Basic connectivity verification

### 2. **Functional Tests** "Does it work correctly?"

- Data validation
- Business logic verification
- Expected behavior confirmation

## Testing Tools: JavaScript vs CURL

### JavaScript/Fetch

- Web-based testing
- Visual interfaces
- Great for beginners
- Interactive learning

### CURL

- Command-line tool
- Universal availability
- Scriptable automation
- Professional standard

**Both test the same API - different approaches!**

## Our Student Management API

|        |             |                      |
|--------|-------------|----------------------|
| GET    | /students   | → Get all students   |
| GET    | /students/1 | → Get student by ID  |
| POST   | /students   | → Create new student |
| PUT    | /students/1 | → Update student     |
| DELETE | /students/1 | → Delete student     |

## Student Data Model

```
{  
  "id": 1,  
  "name": "Alice Johnson",  
  "email": "alice@university.edu",  
  "major": "Computer Science",  
  "year": 3  
}
```



# Shell Programming

- On Linux and macOS, shell scripts are the most common choice for REST API testing.
- On Windows, PowerShell is the modern equivalent, though many developers still prefer Bash scripts (via Git Bash or WSL) for cross-platform compatibility.
- In this section, we focus mainly on shell scripts.

## test\_get\_all.sh

- A variable in a shell script is assigned with `=`, but notice that there is no space between the operator.
- The variable is used with `$` prepended.

```
API_BASE_URL="http://localhost:8000"  
VERBOSE=false
```

```
# Colors for output  
RED='\033[0;31m'  
GREEN='\033[0;32m'  
YELLOW='\033[1;33m'  
BLUE='\033[0;34m'  
MAGENTA='\033[0;35m'  
CYAN='\033[0;36m'  
NC='\033[0m' # No Color
```

```
echo -e "${GREEN}✅ $test_name: $message${NC}"
```

## Function

- Functions are defined as follows.
- The arguments are assigned as \$1, \$2, and so on.

```
print_result() {  
    local test_name= "$1"  
    local success= "$2"  
    local message= "$3"  
    local data= "$4"
```

## If Statement

- If/else statement is used as follows.
- The conditional expression is inside the `[[ ... ]];` block.
- We can add the `else` block.

```
if [[ "$success" == "true" ]]; then
    echo -e "${GREEN}✅ $test_name: $message${NC}"
else
    echo -e "${RED}❌ $test_name: $message${NC}"
fi
}
```

## echo & function call

- To print out the result, we use `echo` .
- To call the shell function, we use the name of the function followed by matching arguments.

```
if [[ "$VERBOSE" == "true" && -n "$data" ]]; then
    echo -e "${CYAN}    Response: $data${NC}"
fi
```

```
...
```

```
print_result('name', ' success', 'message', 'data');
```

## make\_curl\_request

- The curl command needs multiple arguments.
- We can simplify it using a shell function.

```
make_curl_request() {  
    local url= "$1"  
    local method= "$2"  
    local data= "$3"  
    local content_type=" application/json"  
  
    if [[ -n "$data" ]]; then  
        curl -s -w "\n%{http_code}" -X "$method" \  
            -H "Content-Type: $content_type" \  
            -d "$data" \  
            "$url"  
    else  
        curl -s -w "\n%{http_code}" -X "$method" "$url"  
    fi  
}
```

- In this example, we call the `curl` command with various arguments.
- Using the if statement, we separate the case when the `$data` is given or not.
- This is the case when data is not given.
  - `-s` silences progress and error messages.
  - `-w "\n%{http_code}"` appends the HTTP status on a new line after the response body.
  - `-X "$method"` specifies the HTTP method to use (GET, POST, etc).

- We need "\n%{http\_code}" option to use the HTTP status to check if the test is success or not.
  - We get the HTTP status to get the last line (tail -n1).

```
response=$(curl -s -w "%{http_code}" \
    http://localhost:8000)
http_code=$(echo "$response" | tail -n1)

if [ "$http_code" = "200" ]; then
    echo "✅ Server running!"
else
    echo "❌ Connection failed"
fi
```



## Getting the JSON data except for the HTTP Code

- We need to get the JSON data except for the last line.
- However, this code does not work for FreeBSD-based UNIX systems (such as Mac).

```
local json_data=$(echo "$response" | head -n -1)
```

- Instead, we should use this command to get the lines except for the last one (sed \$d).

```
extract_json_data() {  
    local response= "$1"  
    echo "$response" | sed '$d'  
}  
local json_data=$(extract_json_data "$response")
```

## Get the HTTP code and JSON data

- So, this is the pattern to get the HTTP code and JSON data from the REST API server to explain the idea in the examples.

```
http_code=$(echo "$response" | tail -n1)
json_data=$(echo "$response" | head -n -1)
if [ "$http_code" = "201" ]; then
```

## Use the Grep command to extract information

- `grep` searches for patterns in a stream or file — here, it's looking for the exact text `"success":true`
  - The `-q` flag stands for quiet (or silent):
  - It suppresses output — nothing is printed to the terminal.
  - Instead, it uses the exit code to indicate if a match was found.

```
if echo "$response" | grep -q '"success":true'; then
    echo "✅ Success field found"
fi
```

```
{  
  "id": 123,  
  "name": "Alice",  
  "success": true  
}
```

- We need to extract the 123 from this JSON string.
- In this case, we can use grep.

```
student_id=$(echo "$json_data" | \  
  grep -o '"id":[0-9]*' | \  
  grep -o '[0-9]*')
```

- `grep -o '"id":0-9*' Searches for a pattern like "id":123 and outputs that match using -o'.`
- ``grep -o' 0-9*' Extracts only the numeric part from the above string.`

## Our Complete Testing Suite

### Web Interface ([index.html](#))

- Visual feedback with JavaScript
- Interactive testing
- Great for learning
- Real-time results

## Command Line JavaScript (test\_runner.js)

(Optional) Run this when you know `node.js` and how to run a `node.js` script.

- Node.js automation
- Detailed JSON validation
- Programming examples

## CURL Scripts (test\_runner\_curl.sh/.bat)

- Universal tool
- Shell scripting examples
- Cross-platform support

## Running the Tests

### Step 1: Start API Server

```
cd api  
php -S localhost:8000
```

### Step 2A: Web Interface

Open `api_tests/javascript/index.html` in browser (as a file)

### Step 2B: JavaScript CLI

(Optional) Run this when you know how to use `node.js`.

```
node api_tests/javascript/test_runner.js --verbose
```



## Step 2C: CURL Scripts

Running the script on Windows may cause some issues; in this case, use WSL2.

```
# Linux/Mac
./api_tests/curl/test_runner_curl.sh --verbose

# Windows
api_tests\curl\test_runner_curl.bat
```

## Error Testing Examples

### Test Invalid Data:

#### JavaScript

```
const invalidStudent = {
  name: " ", // Empty name
  email: "invalid-email", // No @
  year: "not-a-number" // Wrong type
};

const response = await fetch('/students', {
  method: 'POST',
  body: JSON.stringify(invalidStudent)
});

// Should return 400 Bad Request
assert(response.status === 400);
```

#### CURL

```
# Test with invalid data
invalid_data='{
  "name": " ",
  "email": "invalid-email",
  "year": "not-a-number"
}'

response=$(curl -s -w "%{http_code}" \
  -X POST \
  -H "Content-Type: application/json" \
  -d "$invalid_data" \
  http://localhost:8000/students)
http_code=$(echo "$response" | tail -n1)
if [ "$http_code" = "400" ]; then
  echo "✅ Validation works!"
fi
```

## Test 1: Connection Test

**Goal:** Verify the server is running and responding

### JavaScript

```
async function testConnection() {
  const response = await fetch(
    'http://localhost:8000'
  );

  if (response.ok) {
    console.log('✅ Server running!');
  } else {
    console.log('❌ Connection failed');
  }
}
```

### CURL

```
# Basic connection test
curl -s http://localhost:8000

# With status code check
response=$(curl -s -w "%{http_code}" \
  http://localhost:8000)
http_code=$(echo "$response" | tail -n1)

if [ "$http_code" = "200" ]; then
  echo "✅ Server running!"
else
  echo "❌ Connection failed"
fi
```

## ✓ Test 2: GET All Students

**Goal:** Verify the API returns student data correctly

### JavaScript

```
async function testGetStudents() {
  const response = await fetch(
    'http://localhost:8000/students'
  );
  const data = await response.json();

  // Validate structure
  if (data.success &&
    Array.isArray(data.data)) {
    console.log('✓ Structure OK');
  }

  // Validate count
  if (data.count === data.data.length) {
    console.log('✓ Count matches');
  }
}
```

### CURL

```
# Get students and validate
response=$(curl -s \
  http://localhost:8000/students)

# Check for success field
if echo "$response" | grep -q '"success":true'; then
  echo "✓ Success field found"
fi

# Check for data array
if echo "$response" | grep -q '"data":\['; then
  echo "✓ Data array found"
fi

# Check for count field
if echo "$response" | grep -q '"count":[0-9]'; then
  echo "✓ Count field found"
fi
```

## Test 3: POST Create Student

**Goal:** Create a new student and verify the data

### JavaScript

```
async function testCreateStudent() {
  const newStudent = { name: 'Test Student', ... , year: 2};
  const response = await fetch(
    'http://localhost:8000/students', {
      method: 'POST',
      headers: {
        'Content-Type': 'application/json'
      },
      body: JSON.stringify(newStudent)
    });
  const result = await response.json();
  // Validate creation
  if (response.status === 201 &&
    result.data.name === newStudent.name) {
    console.log('✅ Student created!');
  }
}
```

### CURL

```
new_student='{
  "name": "Test Student CURL", ..., "year": 1
}'
response=$(curl -s -w "%{http_code}" \
  -X POST \
  -H "Content-Type: application/json" \
  -d "$new_student" \
  http://localhost:8000/students)
http_code=$(echo "$response" | tail -n1)
json_data=$(echo "$response" | head -n -1)
if [ "$http_code" = "201" ]; then
  echo "✅ Student created!"
  # Extract ID for later use
  student_id=$(echo "$json_data" | \
    grep -o '"id": [0-9]*' | \
    grep -o '[0-9]*')
fi
```

## Test 4: PUT Update Student

Goal: Update a student and verify changes

### JavaScript

```
async function testUpdateStudent(id) {
  const updateData = {name: 'Updated Student',major: 'Data Science'};
  const response = await fetch(
    `http://localhost:8000/students/${id}`, {
      method: 'PUT',
      headers: {
        'Content-Type': 'application/json'
      },
      body: JSON.stringify(updateData)
    });
  const result = await response.json();
  // Validate update
  if (result.data.name === updateData.name &&
    result.data.major === updateData.major) {
    console.log('✅ Student updated!');
  }
}
```

### CURL

```
update_data=' {"name": "Updated Test Student",
               "major": "Data Science"}'
response=$(curl -s \
  -X PUT \
  -H "Content-Type: application/json" \
  -d "$update_data" \
  http://localhost:8000/students/$student_id)

# Validate update
if echo "$response" | grep -q "Updated Test Student"; then
  echo "✅ Name updated!"
fi

if echo "$response" | grep -q "Data Science"; then
  echo "✅ Major updated!"
fi
```

## Test 5: DELETE Student

**Goal:** Delete a student and verify removal

### JavaScript

```
async function testDeleteStudent(id) {
  // Delete the student
  const response = await fetch(
    `http://localhost:8000/students/${id}`, {
      method: 'DELETE'
    });
  if (response.ok) {
    // Verify deletion
    const verifyResponse = await fetch(
      `http://localhost:8000/students/${id}`
    );
    if (verifyResponse.status === 404) {
      console.log('✅ Student deleted!');
    }
  }
}
```

### CURL

```
response=$(curl -s \
  -X DELETE \
  http://localhost:8000/students/$student_id)

if echo "$response" | grep -q '"success":true'; then
  # Verify deletion
  verify_response=$(curl -s -w "%{http_code}" \
    http://localhost:8000/students/$student_id)
  verify_code=$(echo "$verify_response" | tail -n1)

  if [ "$verify_code" = "404" ]; then
    echo "✅ Student deleted and verified!"
  fi
fi
```

## Advanced CURL Techniques

### Debugging with Verbose Output:

```
curl -v http://localhost:8000/students
```

### Save Response to File:

```
curl -s http://localhost:8000/students > students.json
```



## Check Response Time:

```
curl -w "Time: %{time_total}s\n" -s http://localhost:8000/students
```

## Follow Redirects:

```
curl -L http://localhost:8000/students
```

## Custom Headers:

```
curl -H "Authorization: Bearer token123" \  
      -H "Accept: application/json" \  
      http://localhost:8000/students
```

# What Makes a Good API Test?

## Specific

- Test one thing at a time
- Clear pass/fail criteria
- Focused validation

## Reliable

- Consistent results
- No random failures
- Independent of other tests

## Fast ⚡

- Quick execution
- Immediate feedback
- Suitable for frequent running

## Clear 💡

- Easy to understand
- Descriptive error messages
- Good documentation

## Test Anatomy: The AAA Pattern

```
# ARRANGE: Prepare test data
new_student=' {"name": "Test", "email": "test@edu"}'

# ACT: Execute the API call
response=$(curl -s -X POST -H "Content-Type: application/json" \
  -d "$new_student" http://localhost:8000/students)

# ASSERT: Verify the results
if echo "$response" | grep -q '"success":true'; then
  echo "✅ Test passed!"
else
  echo "❌ Test failed!"
fi
```

Every good test follows this pattern!

## **Testing Checklist**

### **For Each Endpoint Test**

- ☐ **HTTP Status Code** - Is it what we expect?
- ☐ **Response Structure** - Does it match our API spec?
- ☐ **Data Types** - Are fields the right type?
- ☐ **Required Fields** - Are mandatory fields present?
- ☐ **Business Logic** - Does the data make sense?
- ☐ **Error Handling** - What happens with bad input?

## Common Testing Mistakes

### Don't Do This:

- Test multiple things in one test
- Ignore HTTP status codes
- Assume data structure without checking
- Skip error scenarios
- Make tests dependent on each other

## Do This Instead:

- One assertion per test concept
- Always check status codes first
- Validate response structure
- Test both success and failure cases
- Make tests independent



## CURL vs JavaScript: When to Use What?

### Use CURL When:

- Quick manual testing
- Shell script automation
- CI/CD pipelines
- Server environments
- Learning HTTP basics
- Cross-platform compatibility

### Use JavaScript When:

- Web application testing
- Complex data validation
- Interactive interfaces
- Learning programming concepts
- Frontend integration testing
- Rich error reporting

## Key Takeaways

### Testing is Essential

- Prevents bugs in production
- Builds confidence in your code
- Improves code quality

### Multiple Tools Available

- JavaScript for web-based testing
- CURL for command-line automation
- Both achieve the same goals

## Start Simple

- Connection tests first
- Basic functionality second
- Edge cases third

## Be Systematic

- Test all HTTP methods
- Validate response structure
- Check error scenarios